# The Disappearing Architect: 21st Century Practice and the Rise of Intelligent Machines

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Figure 1. Building the Tower of Babel[1]

## THE ARCHITECT'S TRADITIONAL ROLE

When looking at the cultural role of architects throughout history only subtle changes are evident. The Egyptian, Greek, and Roman definition of what constitutes an architect's responsibility are all fairly similar to our impressions of the role of an architect today - generally, a conceiver of buildings, and one who oversees the process of construction. The medieval architect perhaps has the most ill-defined role in terms of contemporary standards, being equal parts 'master-craftsman' and 'master-builder'.[2] Through the vehicle of this rich history the contemporary architect, whether consciously or not, has some feeling or recognition of the enduring aspect of the architectural profession. Accordingly, contemporary western culture celebrates architecture (at least superficially) as a profession worth aspiring to. New paradigms of architectural practice and production, arising first as a result of industrialization, but most recently with the rise of the computer as a quickly evolving and impactful entity within architectural practice, threaten the traditional role of the architect. This threat evokes new modes of machinic architectural production, and raises questions about the future role of human designers.

Our specific roles as human designers have been greatly influenced by technological advances in the 19th and 20th centuries. Nigel Cross, in *The Automated Architect*, identifies the contemporary role of the practicing architect as directly related to the process of industrialization – pointing out that the "hallmark of the industrialized production system is the fragmentation of tasks and the 'division of labor'." The "separation of designing from making" and the use of drawings as an "abstract consideration of form" are, for Cross, both derivatives of the process of industrialization.[3] When we compare the nuances of the architect's role today to that of the ancients, we notice clear differences between the extent of their responsibilities and ours. In the past, architects have been much more intimately involved in the process of construction than architects are today. In fact, our training as contemporary architects is geared less toward construction, in the form of materials and methods inquiries, and

more toward the abstract formal considerations that Cross mentions. This and other examples indicate how the process of industrialization has helped create a separation of tasks that has stationed architectural practice into a specialized realm, currently excluding specific characteristics of craft and building that once were major components in the constitution of our role as architects.

## EARLY 20th CENTURY EFFECTS ON DESIGN THINKING WITH THE RISE OF NEW INFORMATION TECHNOLOGIES

Figure 2. The Fountainhead[4]

In the early 20th century the influence of the industrial age on architecture was clear: the aesthetics that architecture had embraced were undoubtedly the aesthetics of the machine. The infatuation with machine production, along with the allure of the products and forms that it tended to produce, became the era's zeitgeist. What began as an innocent love affair with the 'new' eventually became a form of blind love epitomized at its height by International Style Modernism. In *Technics and Civilization* Lewis Mumford claims:

> "If anything was unconditionally believed in and worshipped during the last two centuries, at least by the leaders and masters of society, it was the machine; for the machine and the universe were identified, linked together as they were by the formulae of the mathematical and physical sciences; and the service of the machine was the principal manifestation of faith and religion: the main motive of human action, and the source of most human goods. Only as a religion can one explain the compulsive nature of the urge toward mechanical development without regard for the actual outcome of the development of human relations themselves."[5]

The Second World War, having displayed the exaggerated horrors of the machine, may well be the apogeic point in history where we begin to notice a shift in these affections. At this point, however, the cultural mentality that had established itself during the one-hundred fifty plus years of industrial production had become a value too deeply embedded in culture to allow for total retreat. As our infatuation slowly faded, the modes of industrial production began to seem the norm, somehow natural to our humanity.

The mid-to-late 20th century includes another principal shift in design thinking that is due in large part to the rise of new information and material technologies born out of the two world wars. There were two significant cultural changes that evolved from the post war era that had a significant impact on architectural thought and practice. First, there was a major increase in building and construction types as a direct result of wartime production and experimentation. Second, there was a vast and sudden increase in population due in large part to an escalation in American wealth. An increase in population meant an increase in the number of buildings being built and the introduction of new building types and materials meant a steep learning curve for architects. These evolutions in American culture were met with information management strategies (themselves born out of techniques devised during the Second World War) that helped architects deal with the new complexities arising in the built environment.[6]

One of the chief additions to the established architecture delivery system during this period was William Pena's Problem Seeking architectural programming method. This method, developed by Pena in the 1960's and published in 1969, had its roots in the post war building boom that was taking place in the United States at the time. The Problem Seeking method was a means of establishing order and control over a system that had grown increasingly complex during the twenty years following the war. Simply put, it was a means of systematizing architectural knowledge.

Perhaps not coincidentally, during the same period, Christopher Alexander publishes *Notes on the Synthesis of Form* wherein a computer-based method of cluster analysis acts as a model towards the solution of a design problem. A decade later he would publish *The Pattern Language*, a building system for laypeople that utilizes a taxonomy of spatial so-

lutions derived from an exploration of established precedents. Alexander's book operates as a guide that when carried out results in an artifact that is in keeping with well established and tested human building traditions.

Just as the discipline of architecture is dealing with the paradigmatic shifts resulting from cultural evolutions brought about by the war, a new instrument is entering the mainstream of cultural conscience and beginning to have an impact on architectural thought and production. Many of the new information organization models were byproducts, consciously or subconsciously, not of the machine age but of the computer age and the new modes of thinking that it instigated. Nigel Cross addressed these issues in the 1970's in *The Automated Architect.* Here Cross takes the introduction of the computer into architecture to its logical conclusion and inquires as to whether the computer will eventually be a "virtual architect in its own right".[7] Nicholas Negroponte proposes a similar idea in his now famous book *Soft Architecture Machines*, also published in the 1970's, and predicted that the computer might someday become a design companion, operating in much the same way as a human design partner might.[8]

This quick glance at the evolution of architecture in the 20th century points to a primary direction of architectural thought during this period toward the systematization of knowledge masked as an effort to alleviate the 'burdens' of an increased pool of knowledge for the individual practitioner. Through this systemic method a gradual yet continual extraction of knowledge from individual practitioners is catalogued and supplied to the entire discipline, thus creating a new, shared knowledge. This extraction of expertise is a primary step in replacing many of the traditional roles of the architect and is the epitome of the aforementioned tendency of the mechanical and information age – standardization, and the division of labor.

## THE COMPUTER BECOMES EMBEDDED IN EVERYDAY PRACTICE

In 1977 William J. Mitchell published *Computer-Aided Architectural Design* as an introduction to the practicing architect about how computers could be employed in the workplace. Since Mitchell's publication there have been numerous advances in the use of the computer as a design tool. The process of evolution of these advances can be compared to Lewis Mumford's view of how tools, as extensions of man's organism, evolve. In *The Transformations of Man* Lewis Mumford argues that the evolutionary process and development of our tools has always tended toward the intellectual, and that

> "the instinctual life of man has been losing its grip in the course of history, as his conscious intelligence has gained firmer control over one activity or another. In achieving that control, man has transferred authority from the organism itself to the process that intelligence analyzes and serves - that is, the causal process, in which human actors are given the same status as non-human agents."[9]

Mumford further describes this process as a "shift to a world directed solely by intelligence"[10]

The first generation of Computer Aided Drafting (CAD) systems that filtered into architectural practice primarily emulated hand drafting and were sold as tools that would aid in the speed of project production. This generation of CAD systems evolved, taking drafting a step further by introducing spatial visualization components via streamlined 3D (and 4D) software with rendering capabilities. This was simply further development of a tool that acted as a replacement for activities once accomplished by hand, whether in the form of models or drawings. The first and second generation CAD tools were the equivalent of what Lewis Mumford might define as early human tool development – as they merely replaced a specific part of the body (the hand) to achieve their ends.[11]

The introduction of Building Integrated Modeling (BIM) software represents the second (and current) generation of design computing in the architectural realm. BIM can be defined as "the management of information and the complex relationships between the social and technical resources that represent the complexity, collaboration, and interrelationships of today's organizations and environment."[12] Just as the increase in complexity of building systems after World War II caused an evolution in the modes of architectural production, the digitization of building systems knowledge via easily linked, extensive networks of information, has created a 'need' for the systematization and ordering of this new knowledge. This second generation CAD tool is what Mumford might consider a further evolution

and development of a tool that is becoming more closely related to human intelligence.[13]

The tools that represent the third generation of the computer in architectural practice have advanced beyond the "CAD" nomenclature and are now more specifically defined as Computer Based Design (CBD) systems; a reference to the nature of these tools as design companions. CBD tools have been talked about since at least the 1970's by figures such as Nigel Cross and Nicholas Negroponte. Negroponte, in *Soft Architecture Machines*, asks us to envision computers as designers, partners, and environments. He conceives of "machines that speak and respond to a natural language"[14] so that designers do not have to translate their thoughts into the language of the machine. Negroponte asks us to imagine "a machine that can follow your design methodology and at the same time discern and assimilate your conversational idiosyncrasies."[15] The interaction between the designer and the machine would be "one of mutual development." It is Negroponte's hope that the use of the computer as a design aid will result in a built environment that responds to our every need with a quality "most closely approximated in indigenous architecture."[16] In other words, with intentions strikingly similar to those of Christopher Alexander, Negroponte is alluding to an "architecture without architects".[17]

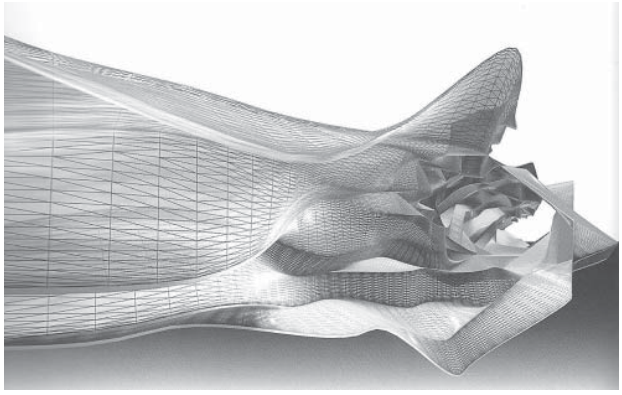

Figure 3. Digital Tools as Companions[18]

There are a number of software systems currently being developed that aptly fit into the third generation category of architectural computing. Contemporary systems such as OPTIMA, KNODES, and SEED are knowledge-based tools that replicate human expertise to provide cognitive support during the process of design. These are 'static' tools in that there is a fixed support system with no ability to evolve based on a real-time analysis of the problems, process, and resultant design solutions. Due to this issue new tools (ID3, ECOBWEB, BRIDGER, NODES, BOGART, ARGO) have been developed that employ a 'learning algorithm' which enables the computational tool to adapt to the context of a design problem, gaining design process and product knowledge along the way.[19]

Yehuda Kalay, in *Architecture's New Media*, mentions the "considerable efforts in architectural design research to develop knowledge-based programs that can synthesize solutions on the basis of analogical reasoning, case-based reasoning, design rules derived from the experiences of good designers, even formalized shape transformations that can generate forms within an established corpus of architectural (and other) work."[20] Likewise, Thomas P. Moran suggests that a codification of all our present design knowledge would be beneficial to the use of the computer as a design companion (what he calls an 'Architect's Advisor). In this system the computer would not make any decisions for the architect but rather would offer potential solutions that the architect could accept or reject based on their own knowledge of design practice.[21] In an article titled *ICADS Expert Design Advisor: An Aid to Reflective Thinking,* Myers and Pohl discuss an "Intelligent Computer Aided Design System"[22] that acts as an expert design advisor during the drafting phase of architectural design. The system would operate in real time analyzing climate data, cost, acoustics, structure, access, etc., providing recommendations during the design process.

## RISE OF INTELLIGENT ARCHITECTURE MACHINES

The three previously mentioned generations of computer implementation in architecture are either in development, meaning there are already working applications, or are currently available in main stream practice today. The fourth (and perhaps final) generation of the introduction of computers into practice is a widely discussed topic and involves the evolution of computational tools into intelligent machines. These machines will be an accumulation of the best working properties of the previously mentioned systems, will know how to access all knowledge pertinent to the design task at hand (and know how to make distinctions between

what is pertinent and what is not), and will be able to generate complete design solutions without the need of an architect to oversee the process.

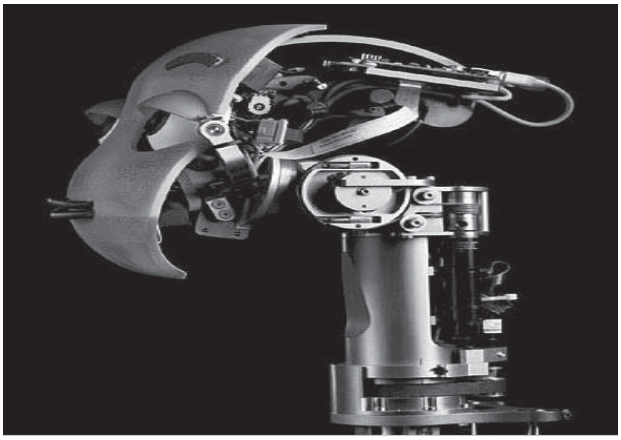

Figure 4. Intelligent Machines[23]

The myriad of articles over the past 30 years pertaining to the itemization or categorization of the nature of the design process, all in an attempt to streamline or better predict the inherent maneuvers within the process, is itself a prediction of a future design state in which computers – paramount tools of organization and order – will dictate the process of design. In *The Nature of Design Activity* Nigel Cross discusses research done in the areas of design methodology and problem solving and, though he concludes that "most systematic procedures are ill-matched to the conventional design process"[24], he cautions that attempts at systematizing the design process should not be discarded in favor of relying on conventional methods. The crucial point here is not that systematized procedures have been ineffective but that there is a trend toward the systematization of the design process itself and that with eventual successes in these realms there will be a swifter evolution toward utilizing the computer as a design companion. The eventuality of this is that the computer will take over as sole designer.[25] John Gero among others has done a lot of work toward determining the behavior of human designers in hopes that an understanding of the human design process will lead to CAAD support tools that act as design companions for future design work.

Peter Manning and Samir Mattar, in a chapter of *Evaluating and Predicting Design Performance*, discuss the development of expert systems embedded within computational tools that would act, in the very least, as design companions but might someday likely have the potential to replace the role of the designer in the total design of buildings. It is the belief of many people working in the realm of computational design that computers *should* and someday *will* amplify human design and decision-making capacity.[26] Gero and Peng describe computer-aided design tools that are able "to learn conceptual knowledge as they are being used" and that "adapts its behaviors to the changing environment." Gero and Peng further argue that "the development of computer aided design tools has moved from representation to knowledge encoding and support in knowledge based systems."[27]

The dispute over whether computers will ever attain 'intelligence' is ongoing and perhaps long lasting. Champions of intelligent machines point to our own lack of knowledge about what constitutes intelligence, or even perhaps the mystique we give to intelligence (and meaning) as if they are elements of a spiritual nature: the impenetrability *of* the mind *by* the mind. Marvin Minsky, in *Why People Think Computers Can't*, describes 'meaning' as a things connection to all other things conceived. Minsky suggests that "our questions about thinking machines should really be questions about our own minds",[28] further asserting that one reason why many people don't believe that artificial intelligence is possible is that they believe that meaning is a singular thing, somehow definable and existing outside of any context. Minsky asserts that, "there is a special irony when people say machines cannot have minds, because…we're only now beginning to see how minds could possibly work, using insights that come directly from attempts to see what complicated machines can do."[29] We are soon approaching the same quandaries in architecture. Computational design aids will elicit questions about what really constitutes design, and about what constitutes value in architecture. Negroponte argues that a "perpetual cross-examination of ideas by both man and machine will encourage creative thought that would otherwise be extinguished by the lack of an antagonizing (and thus challenging) environment."[30] Whatever one's individual beliefs may be regarding the future direction architectural computing, the evidence points to a trajectory that is set toward an architecture that will continue to relinquish control to digital machines.

An examination of the evolution of 20th century architectural practice indicates trends toward a further division of labor and systematization of knowledge. Early 20th century architecture found its greatest influence in the industrial ideals of the assembly line and mass production. The means of production had an enormous impact on formal and spatial derivations during this period. Beyond this, however, industrial production methods filtered into our cultural value systems, becoming analogues for new types of information storage and retrieval methods, building methods, and overall ways of thinking. Our cultural values evolved during the 20th century, first influenced by the machine and its modes of production and next by the computer with its structural and organizational nuances. The existing late 20th and early 21st century modes of data storage and dissemination foretell a paradigmatic change in architecture and other disciplines wherein stored pools of expert knowledge will be highly categorized and easily retrievable; building integrated modeling (BIM) is an example of this. BIM represents an initial attempt at replacing traditional architectural roles with design computing tools, chiefly in the form of information gathering and management. Information that was once gathered by individuals or was a part of an individual's expertise now is retrieved through a database of stored ideas; a replacement of the primary and crucial design stage during which one is allowed time to ruminate over the design problem. Failures in developing artificial intelligence systems have been well documented but all evidence points to an eventual success (in one form or another) in this area. Knowledge-based tools have already been developed that aid the designer by providing expert knowledge to specific design problems. The missing link in this equation is the establishment of 'intelligent' and 'creative' computational tools. Researchers are working diligently to create models and algorithms for these human characteristics. The conclusion of these efforts will be the development of machines that no longer are simply information storage and retrieval devices but will also be able to 'read and react' to the design problem in real time; a virtual replacement for their human counterparts – the end of the traditional roles of the architect.

## ENDNOTES

1. D. Jacobs, *Architecture*, Newsweek Book, 1974

2. Spiro Kostof, *The Architect: Chapters in the History of the Profession*, University of California Press, Berkeley and California Press, Los Angeles, California, 1977

3. Nigel Cross, *The Automated Architect*, Viking Penguin, New York, 1977

4. The Fountainhead, LIFE, http://images.google.com/hosted/life/l?imgurl=430ec01b7b6ee5ac&q=THE+FOUNTAIN+HEAD&usg=__0V14FW54znEosO21S8

5. Lewis Mumford, *Technics and Civilization*, Harcourt Brace and Company, New York, 1934

6. Edith Cherry, *Programming for Design*, John Wiley and Sons, New York, 1999

7. Nigel Cross, *The Automated Architect*, Viking Penguin, New York, 1977

8. Nicholas Negroponte, *Soft Architecture Machines*, The MIT Press, Massachusetts and London England, 1975

9. Lewis Mumford, *The Transformations of Man*, Harper and Brothers Publishers, New York, 1956

10. Ibid

11. Ibid

12. Finith Jernigan, *Big BIM Little BIM*, 4 Site Press, Salisbury, MD, 1993

13. Lewis Mumford, *The Transformations of Man*, Harper and Brothers Publishers, New York, 1956

14. Nicholas Negroponte, *Soft Architecture Machines*, The MIT Press, Massachusetts and London England, 1975

15. Ibid

16. Ibid

17. Ibid

18. Digital Tools as Companions, *Architecture and Computers*, Laurence King Publishing, pg138

19. Wei Peng, John S. Gero, *Learning While Optimizing a Design: a situated agent-based design interaction tool*, Key Centre of Design Computing and Cognition, University of Sydney, Australia

20. Yehuda Kalay, *Architecture's New Media*, The MIT Press, Boston, MA, 2004

21. Thomas P. Moran, *Artificial / Intelligent Architecture: computers in design*, Architectural Record, March, 129-34

22. Myers and Pohl, *ICADS Expert Design Advisor: An Aid to Reflective Thinking*, Knowledge Based Systems, 1992

23. Intelligent Machines, *Latest News*, http://images.google.com/imgres?imgurl=http://www.

freshnews.in/wp-content/uploads/2008/04/robots.jpg&imgrefurl=http://www.freshnews.in/robots-to-now-learn-from-experiences

24. Nigel Cross, Analyzing Design Activity, John Wiley and Sons, 1997

25. Nigel Cross, Developments in Design Methodology, John Wiley and Sons, New York, 1984

26. Note: This is implied by Kalay in *Evaluating and Predicting Design Performance*. Also by Peter Manning and Samir Mattar in *A Preliminary to Development of Expert Systems for Total Design of Entire Buildings*

27. Wei Peng, John S. Gero, *Computer-Aided Design Tool that ADapt*, CAD Futures conference, 2007

28. Marvin Minsky, *Why People Think Computers Can't*, First published in AI Magazine, vol. 3 no. 4, Fall 1982

29. Ibid

30. Ibid